BITUMINOUS FROTH INLINE STEAM INJECTION PROCESSING

FIELD OF THE INVENTION

This invention relates to bitumen processing and more particularly is related to heating bituminous froth using inline steam injection.

BACKGROUND TO THE INVENTION

In extracting bitumen hydrocarbons from tar sands, one extraction process separates bitumen from the sand ore in which it is found using an ore washing process generally referred to as the Clark hot water flotation method. In this process, a bitumen froth is typically recovered at about 150°F and contains residual air from the flotation process. Consequently, the froth produced from the Clark hot water flotation method is usually described as aerated bitumen froth. Aerated bitumen froth at 150°F is difficult to work with. It has similar properties to roofing tar. It is very viscous and does not readily accept heat. Traditionally, processing of aerated bitumen froth requires the froth to be heated to 190° to 200°F and deaerated before it can move to the next stage of the process.

Heretofore, the aerated bitumen froth is heated and de-aerated in large atmospheric tanks with the bitumen fed in near the top of the vessel and discharged onto a shed deck. The steam is injected below the shed deck and migrates upward, transferring heat and stripping air from the bitumen as they contact. The method works but much of the steam is wasted and bitumen droplets are often carried by the exiting steam and deposited on nearby vehicles, facilities and equipment.

SUMMARY OF THE INVENTION

The invention provides an inline steam heater to supply heated steam to a bitumen froth by direct contact of the steam to the bitumen froth resulting in superior in efficiency and environmental friendliness than processes heretofore employed.

In one of its aspect, the invention provides an inline bitumen froth steam heater system including at least one steam injection stage, each steam injection stage followed by a mixing stage. Preferably, the mixing stage obtains a mixing action using static mixing devices, for example, using baffle partitions in a pipe. In operation, the invention heats the bitumen froth and facilitates froth deaeration by elevating the froth temperature. In operation the bitumen froth heating is preferably obtained without creating downstream problems such as emulsification or live steam entrainment. The froth heater is a multistage unit that injects and thoroughly mixes the steam with bitumen resulting in solution at homogenous temperature. Steam heated to 300 degrees Fahrenheit is injected directly into a bitumen froth flowing in a pipeline where initial contact takes place. The two incompatible substances are then forced through a series of static mixers, causing the steam to contact the froth. The mixer surface area and rotating action of the material flowing through the static mixer breaks the components up into smaller particles, increasing contact area and allowing the steam to condense and transfer its heat to the froth. The reduction in bitumen viscosity also allows the release of entrapped air.

Other objects, features and advantages of the present invention will be apparent from the accompanying drawings, and from the detailed description that follows below. As will be appreciated, the invention is capable of other and different embodiments, and its several details are capable of modifications in various respects, all without departing from the invention. Accordingly, the drawings and description of the preferred embodiments are illustrative in nature and not restrictive

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a functional block diagram of a preferred embodiment of a bitumen froth heating process arrangement of the invention.

Figure 2 is a cross section elevation view of an inline steam heater and mixer stage of Figure 1.

Figure 2a is an elevation view of a baffle plate of Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

In accordance with a preferred embodiment of the process two inputs components, namely, bitumen froth and steam, are contacted to produce an output homogenous bitumen product heated to a temperature of 190°F. The input bitumen froth component 10 is supplied at about 150°F. In a pilot plant implementation the input bitumen froth component is supplied via a 28 inch pipeline at a rate of about 10,000 barrels per hour. The input steam component 12 is supplied as a superheated steam at about 500°F and at 150 psi.

Figure 1 shows a functional block diagram of a preferred embodiment of a bitumen froth heating apparatus arranged in accordance with the invention. The input steam component 12 is supplied to a pressure control valve 14 which reduces the pressure to a set point pressure, which is typically about 90 psi. A pressure transmitter 16 is provided to monitor the pressure of the steam downstream from the pressure control valve 14 to provide a closed loop control mechanism to control the pressure of the steam at the set point pressure. The pressure controlled steam is supplied to a temperature control valve 18 that is used to control the supply of condensate 20 to cool the steam to its saturation point, which is about 300°F at the controlled pressure of 90 psi. A temperature sensor 22 monitors the steam temperature downstream from the temperature control valve to provide a closed loop control mechanism to control the temperature of the steam at the temperature set point setting.

The optimum parameters for steam injection vary so a computer 24 executes a compensation program to review the instantaneously supplied instrumentation pressure 26 and temperature 28 measurements and adjusts inlet steam pressure and temperature set point settings as required. A pressure sensor 29 measures the pressure of the input bitumen component 10 to provide the compensation program executing on computer 24 with this parameter to facilitate optimum control of the parameters for steam injection.

To provide a greater capacity for supply or transfer of heat to the bitumen froth component, the pressure and temperature controlled steam 30 is split into two steam sub-streams 30a, 30b. Each steam sub-stream is supplied to a respective steam injector 32a, 32b and the steam injectors 32a and 32b are arranged in series to supply heat to the bitumen froth component stream 10. While two steam injectors arranged in series are shown in the figure, it will be understood that the bitumen froth component stream 10 could equally well be split into two sub-streams and each bitumen froth component sub-stream supplied to a respective steam injector arranged in parallel. Moreover, it will be understood that more than two sub-streams of either the steam component or the bitumen component streams could be provided if process flow rates require. A suitable inline steam injector 32a, 32b is manufactured by Komax Systems Inc. located in California, USA.

An inline steam injection heater works well in heating water compatible fluids but bitumen is not water compatible so additional mixing is advantageous to achieve uniform fluid temperature. Consequently, in the preferred embodiment depicted in Figure 1, the bitumen and steam material flow mixture is passed through an inlet baffle 34a, 34b downstream from the respective steam injector 32a, 32b. The inlet baffle, which is shown more clearly in Figure 2a, directs the material flow mixture downward to initiate the mixing action of the steam component with the bitumen froth component. Mixing of the material flow continues by passing the material flow through static mixers 36a and 36b respectively.

As seen most clearly in Figure 2, the static mixers provide baffles 40 arranged along the interior volume of each static mixer to effect a mixing action of the material flowing through the static mixer. The mixing action of the material flow through the static mixer is provided by arranging the baffles 40 within the static mixer to impart a lateral, radial, tangential and/or circumferential directional component to the material flow that changes repeatedly along the length of the static mixer. Different static mixer designs and baffle arrangements may be used to advantage in mixing the steam component with the bitumen froth component.

A temperature transmitter 42 is located downstream of the mixers 36. The temperature of the material flow exiting the static mixer is measured by the temperature transmitter 42 and is used to control the rate of supply of steam to the inline steam injector 32 by the associated flow control valve 44. In this manner, a closed loop control system is provided to control the supply of the steam component to the bitumen froth component to obtain a set point or target output temperature of the material flow leaving the static mixer 36.

Referring again to Figure 1, the heating system shown in Figure 2 is arranged with a temperature transmitter 42a, 42b located downstream of each respective mixer 36a, 36b. The temperature of the material exiting each static mixer is measured by the temperature transmitter and is used to control the rate of supply of steam to the inline steam injectors 32a, 32b by the associated flow control valve 44a, 44b respectively. In this manner, a closed loop control system is provided to control the supply of the steam component to the bitumen froth component to obtain a set point or target output temperature of the material flow leaving each static mixer stage 36a, 36b.

The water content of the bitumen froth component 10 can range form 30% to 50%. In a pilot plant implementation of the preferred embodiment, each inline steam heater 32a, 32b was found to be capable of heating about 10,000 barrels per hour of bitumen froth by about 30°F utilizing about 80,000 pounds per hour of steam. By way of comparison to conventional process apparatus, the atmospheric tank method would use about 125,000 pounds of steam to achieve a similar heat transfer.

After heating, the heated bitumen froth is delivered to a plant for processing. To facilitate material flow rate co-ordination with the processing plant, the heated bitumen froth may be discharged to a downstream holding tank 46, preferably above the liquid level 48. The heated, mixed bitumen froth releases entrained air, preferably, therefore, the holding tank is provided with a vent 50 to disperse the entrapped air released from the bitumen froth. To maintain the temperature of the heated bitumen froth in the holding tank 46, a pump 50 and recycle line 52 are

provided, which operate to recycle the hot bitumen froth from the holding tank to the process inlet of the heaters.

The invention has been described with reference to preferred embodiments. Those skilled in the art will perceive improvements, changes, and modifications. The scope of the invention including such improvements, changes and modifications is defined by the appended claims.